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Recent FerryBox observations reveal a strong increase in surface seawater pCO₂ in the North Sea

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Surface seawater carbon dioxide partial pressure (pCO₂) in the North Sea, a large temperate shelf sea, was measured between 2014 and 2018 using FerryBox-integrated membrane sensors on ships of opportunity. The use of commercial vessels ensured a high spatio-temporal resolution, with data available year-round in areas belonging to all the stratification regime types found in the North Sea. Average annual cycles revealed a dominant biological control on pCO₂ variability, with thermal effects modulating its amplitude. In the regions of freshwater influence, the biogeochemical characteristics of the riverine end-member also influenced the pCO₂ measured near shore. Deseasonalized winter trends of seawater pCO₂ were positive (ranging from $4.4 \pm 2.0 \mu\text{atm yr}^{-1}$ to $8.4 \pm 2.9 \mu\text{atm yr}^{-1}$ depending on the region), while the trends calculated including all deseasonalized monthly averages were even higher (ranging from $9.7 \pm 2.8 \mu\text{atm yr}^{-1}$ to $12.2 \pm 1.4 \mu\text{atm yr}^{-1}$). All these trends were stronger than the atmospheric pCO₂ trend. Consequently, during our study period, the southern North Sea became a stronger source and the northern North Sea became a weaker sink for atmospheric carbon with implications for the Northwestern European Shelf carbon uptake capacity.